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of the
Defense Science Board
Summer Study on

TECHNOLOGY .BASE MANAGEMENT

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1987 DEFENSE SCIENCE BOARD SUMMER STUDY

ON

TECHNOLOGY BASE MANAGEMENT

"HOW TO IMPROVE THE EFFECTIVENESS AND EFFICIENCY OF THE R&D PROCESS"

TERMS OF REFERENCE

The 1987 DSB Summer Study on Technology Base Management was charged with evaluating the management of the technology base of Department of Defense (DoD) and making recommendations on ways to improve the effectiveness and efficiency of the management process. The thrust of this study was to develop management principles that could guide the Technology Base rather than to develop a more detailed set of recommendations. The conclusions of the panel are derived from a qualitative evaluation of the present system coupled with an understanding of how well (or poorly) recommendations of past studies have been implemented.

It was evident that implementation of any recommendations will face substantial institutional resistance and political difficulties. Accordingly the Study has, in some cases, adopted the mechanism of proposing a series of "experiments" or "demonstrations" or major change which point in the right direction.

It is important to understand that the leadership and vision of motivated individuals and groups are a critical part of technical management. The Study has been as concerned with this aspect of Technology Base management as with more institutional or bureaucratic processes.

The Summer Study did not address certain important specific issues. The Study did not consider the question of adequacy of the present level of Technology Base resources (6.1 + 6.2 + 6.3a), but focused on processes for utilizing available resources more effectively and efficiently. Also, the Study did not consider the balance of support among key technical areas. The focus of today's inquiry was on the process of choice, rather than on specific technology opportunities. There are several other issues of importance which the Study did not address, such as technical management of SDI and support for the U.S. semiconductor industry.

TERMS OF REFERENCE

CHARGE

DOD WIDE MANAGEMENT STRUCTURE FOR TECHNOLOGY BASE ACTIVITY INCLUDING TRANSITION TO MILITARY SYSTEMS

WHAT WE DID NOT CONSIDER

- LEVELS OF RESOURCES
- KEY TECHNICAL AREAS
- SPECIAL ISSUES - SDI, SEMICONDUCTORS

DSB TECHNOLOGY BASE STUDY MEMBERS

The Study participants are listed on the facing viewgraph. As can be seen, this group has extensive experience with Technology Base Management, within DoD, industry and academia.

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WHY A NEW STUDY NOW

Although there have been many studies of the Technology Base over the past fifteen years, there are several changed circumstances which justify a new study at this time:

- There is an increasing risk that the U.S. is losing the technological advantage on which it bases its strategy for military superiority.
- There is a growing perception that the DoD is getting progressively less for its R&D dollar.
- There is a growing appreciation of the overlap between technology advances in the commercial and defense sectors. Accordingly, improved performance of the DoD Technology Base will contribute to the ability of the U.S. to compete in the international marketplace.
- A major reorganization of the DoD Acquisition System is underway as a result of the Packard Commission and the 1986 Goldwater-Nichols Act.

From the perspective of this Study there are two implications of the reorganization of the DoD acquisition system. First, the new Acquisition System is directed by an Under Secretary of Defense with strengthened authority. Second, the reorganization establishes a Vice Chairman of the Joint Chiefs of Staff who, *inter alia*, is responsible for representing the needs of the Joint Chiefs and the CINCs of the Unified and Specified Commands in the acquisition process, the ultimate users of new technology in the acquisition process. There will be substantial demands on the Vice Chairman's attention. However, the Vice Chairman potentially can act as an important influence in assisting the technology transition process.

This Summer Study has relied heavily upon these prior reports and studies; our findings and recommendations are, in general, consistent with them. This Study Group has attempted to formulate the recommendations in a manner that will improve the chances of adoption.

WHY A NEW STUDY NOW

- GROWING CONCERN ABOUT TECHNOLOGY BASE
- NEW DOD ACQUISITION SYSTEM
  - UNDER SECRETARY OF DEFENSE FOR ACQUISITION
  - PACKARD COMMISSION
- ROLE OF NEW VICE CHAIRMAN OF JCS
- FINDINGS BASED ON 16 PAST STUDIES

OBJECTIVES OF TECHNOLOGY BASE 6.1 + 6.2 + 6.3A

Within its charter the Study group focused on two questions:

- Is the Technology Base efficiently producing technology options adequate in number and quality for DoD users and operators?
- How can the transition of new technology to the field be accomplished most effectively?

While both are important, there was general agreement that the second issue is currently more pressing. Basically, the system is better at generating new technology than exploiting it. The problems in exploiting technology go beyond affordability to the way the acquisition system is motivated to make investment decisions, and organized to transition from technological opportunity to fielded systems.

OBJECTIVES OF TECH BASE
6.1 + 6.2 + 6.3A

- THE TECHNOLOGY BASE SYSTEM SHOULD EFFICIENTLY GENERATE FUTURE OPTIONS FOR DOD USERS AND OPERATORS

- THE TECHNOLOGY BASE SYSTEM SHOULD EFFECT THE TRANSITION OF NEW TECHNOLOGY TO THE FIELD

SIZE OF TECHNOLOGY BASE PROGRAM

The Technology Base includes budget R&D categories 6.1, 6.2 and 6.3A. This viewgraph lists FY87 and FY88 resources devoted to the Technology Base. In essence, the Technology Base:

- Provides new technology options for the near (6.2 and 6.3A) and long term (6.1 and 6.2).
- Supports later R&D stages; e.g, system engineering (6.2 and 6.3A).
- Contributes to improved technology utilization and technology transfer (6.3A).

The Study group found universal agreement that a strong Technology Base is critical to long-term U.S. and allied defense capability. Although the DoD currently invests only 2.9% of annual expenditures in 6.1 through 6.3A categories, this small number should not be taken as a measure of its importance. Strength in today's Technology Base is essential to ensure future military superiority. The challenge is to maintain and exploit this advantage.

CATEGORIES CONCEPTUALLY USEFUL

The Study group believes that the current categorization for DoD R&D activity is conceptually appropriate and useful. This categorization is:

- 6.1 Basic Research
- 6.2 Exploratory Development
- 6.3A Advanced Technology Development (Feasibility)
- 6.3B Advanced Development (Based on System Application)
- 6.4 Engineering Development
- 6.5 Management and Support

The Study group notes that this set of categories does not always imply a unidirectional, staged development for innovation. New technology does not necessarily progress to field usage via a program in each category. There are important examples where a 6.1 discovery has found prompt application in fielded systems. There are also cases where technical work in engineering development has uncovered fundamental phenomena and methods. Likewise, 6.3A and higher category projects have uncovered unanticipated knowledge gaps which need to be bridged via 6.1 or 6.2 activity. The 6.3A projects should include budgeting for knowledge gaps; when appropriate, 6.3A funds should be used to solve fundamental problems critical to the success of the specific 6.3A projects.

SIZE OF TECHNOLOGY BASE PROGRAM

$M	FY87	FY88
6.1	891	918
6.2	2,342	2,503
6.3A+	1,690	1,952
TOTAL	4,923	5,373

+DOES NOT INCLUDE SDI

CATEGORIES CONCEPTUALLY USEFUL

- CONCERN WITH INTEGRITY OF ACTIVITY IN CATEGORIES
- PROCESS NON LINEAR
- DO NOT USE 6.1 AND 6.2 TO FUND 6.3A
- DO USE 6.3A TO SOLVE FUNDAMENTAL PROBLEMS WHICH ARISE IN SPECIFIC 6.3A PROJECTS

STRENGTHS AND WEAKNESSES OF SYSTEM

The Study Group spent considerable effort on answering the question "How is the Technology Base system performing compared to the level of resources it receives?" A precise estimate of the performance of the Technology Base system was not formulated by the Study Group. In fact, the group could not find quantitative, objective, output-oriented measures of performance. Such measures simply do not exist. Instead, the panel relied upon the judgment of its members and upon their extensive experience in technology management. The Study group noted some strengths and weaknesses of the DoD Technology Base, as listed on this viewgraph.

The Study Group believes that there is significant reason for concern about the DoD Technology Base. This concern led the Study Group to address a number of important management questions:

- How to speed up technology transition? Is the problem mainly outside the Technology Base arena?
- How to protect, capitalize on and extend existing pockets of excellence?
- How to get and keep good people, especially good managers?
- Have some DoD laboratories or military departments found a more effective way to manage?
- Should new institutions be established?
- Should work be consolidated at new or existing institutions without closing laboratories?
- How to ensure that the right problems are worked on?

Note that here and below the term "laboratories" is employed to mean both government laboratories, government owned, contractor operated (GOCO) laboratories, or federally funded research and development centers (FFRDC). When a distinction is intended between the types of laboratories, it is indicated.

STRENGTHS AND WEAKNESSES OF SYSTEM

STRENGTHS

- ACCEPTANCE OF IMPORTANCE
- GOOD INSTITUTIONAL MEMORY
- POCKETS OF EXCELLENCE

WEAKNESSES (LONGER LIST)

- FOR LONG TERM - RESTRICTED MENU
- SLOW TRANSITION
- RISK AVERSE, TOO SHORT TERM
- GOVERNMENT LABS CANNOT COMPETE FOR TOP TECHNICAL PEOPLE
- CONTRACTING
- NOT GETTING THE MOST FOR THE INVESTMENT
- MICRO-MANAGED

MANAGEMENT OF TECHNOLOGY BASE

The Study Group did not attempt to provide a comprehensive guide or "cook-book" for how the DoD Technology Base system should be managed. Rather the group identified some guidelines that individuals with substantial technical management experience believe to be important and which are not being adequately followed in the present DoD Technology Base system.

- Who is in Charge? At every level of Technology Base management there should be an individual with authority and responsibility to decide what research is pursued, using what strategy and by whom. The execution of a work program should then be continually evaluated to determine how well it is meeting the specified objectives. This is not the case throughout the DoD Technology Base.
- The Technology Base as a Part of the Acquisition System. The Technology Base is not universally viewed as an integral part of the DoD acquisition system. Responsibility begins with USD(A) who has ultimate responsibility for the entire Technology Base. The USD(A) can, indeed must, delegate portions of this overall responsibility to Deputy Under Secretaries and Service Acquisition Executives. It should be done with the objective of reducing the levels between the performers and significant higher authority.
- People. The Study group was unanimous in its view that a central problem with the current Technology Base is the quality of technical people at all levels including both managers and performers. Without good technical people the entire system suffers.
  - At OSD and Military Department Level. Although OSD and Service headquarters staff contain some outstanding individuals, the average talent is not as strong as in the past. This influences both the design, execution, and leadership of the DoD Technology Base.
  - At the Government Laboratories. Civil Service personnel practices are making it progressively more difficult for the government laboratories to compete with the outside world for top technical talent. In the absence of such top talent, laboratory technical performance must eventually suffer.
  - At the Uniformed Military Level. The Study group is concerned that the Services are not providing officers to R&D billets with the technical experience and education required for modern warfare.
  - At the University Level. DoD sponsored basic research should be carried out in a manner which assures that colleges and universities continue to be a source of bright and motivated young people concerned with technical subjects of significance to national security.

These Study Group concerns regarding the DoD Technology Base provided the basis for findings and recommendations in the areas listed. The viewgraphs to follow discuss findings and recommendations on these important issues as well as selected other central issues.

MANAGEMENT OF TECHNOLOGY BASE

PRINCIPLES

- WHO IS IN CHARGE
- PART OF ACQUISITION SYSTEM
- QUALITY OF TECHNICAL PEOPLE
- LEADERSHIP

MAJOR FINDINGS AND RECOMMENDATIONS

- 6.1 CORPORATE RESPONSIBILITY
- MAJOR ISSUE IN LAB MANAGEMENT
- TECHNICAL PERSONNEL FOR MANAGEMENT
- 6.3A TECHNOLOGY TRANSITION
- OTHER CENTRAL ISSUES

6.1 BASIC RESEARCH

Over the long term, the leadership and vitality of the U.S., both economically and militarily, depends extraordinarily on the quality and vision of our program of basic research. If this has been true in the past, it is even more true for the future. It is essential that this central tenet be understood and endorsed at the highest levels of our national leadership. This basic research activity produces new knowledge, new applied concepts, an innovative environment and, most importantly, outstanding technological leaders.

The need for our explicit understanding and re-affirmation of this fundamental proposition is underscored by its conscious recognition in recent years by the many nations which challenge the U.S. both economically and militarily. The U.S. no longer enjoys a comfortable position of leadership in the world in this arena. In fact, the evidence documents the contrary. We have witnessed how whole industries can be wiped out by sudden "technological surprise". Similarly, in the military sphere, we have witnessed how technological surprise can alter very rapidly the balance of power both in specific areas of warfare and in the aggregate. As an example, the recent, unexpected, unplanned, discoveries in superconductivity resulted from high quality basic research conducted with great freedom. These discoveries may impact national economic and military positions in a sudden and major way.

In the U.S. we can observe what is happening to many industries by expedient, shortsighted leadership, lacking a long-range focus. In the military arena where the stakes are even higher than international industrial competitiveness, the same symptoms have increasingly appeared. There is a short-sighted focus in our basic research programs at the expense of visionary, longer-range research. The need for short-term results and immediate "relevancy" to individual Service needs has become the governing criterion in framing a program. DoD-wide research areas (e.g., materials, biotechnology, AI) are being managed within the constraints of Service programs. We have experienced a "research menu squeeze" in which only the most popular programs, justifiable in terms of clearly perceived near-term military relevancy survive the cut. Often left untapped are the longer range but inherently higher leveraged research programs as well as the genius of many scientists working on subjects of ultimately much greater potential importance.

The Defense Science Board is concerned about this trend; it regards the situation as serious and urgently in need of attention. Stated bluntly, DoD "corporate management" has essentially abrogated much of what should be an imperative responsibility for any top management, namely, a constant concern with the long-range vitality and competitiveness of the enterprise and personal participation in effecting the actions which ensure this. The 6.1 program management process exhibits fragmentation and lack of exercised central authority. OSD attention is missing.

6.1 BASIC RESEARCH

FINDINGS

- o IMPORTANT TO NATION
- o PROGRAM DETERIORATING
  - NEED LONGER RANGE AND HIGHER RISK ORIENTATION
  - OVER MANAGED
  - NARROWLY DEFINED RELEVANCE
- o OSD ATTENTION MISSING

BASIC RESEARCH AGENDA FREQUENTLY HAS MULTISERVICE ASPECT--EXAMPLE MATERIALS, BIOTECHNOLOGY, AI

- DESERVES CORPORATE FOCUS

6.1 BASIC RESEARCH - RECOMMENDATIONS

Having expressed this serious concern, what can we do about this decline before it gradually becomes more seriously debilitating? How can we recapture a greater sense of long-range vision for DoD's 6.1 program of basic research? The DSB believes these objectives can be effectively approached by several simple, but essential actions.

Recommendation: The Undersecretary for Acquisition should delegate his acquisition executive leadership of the 6.1 program to an individual within his staff. This individual should be vested with full authority and responsibility for the 6.1 program. Specifically:

- *USD(A) should restate the purpose and mission for the 6.1 program of basic research and explicitly reaffirm its importance, emphasizing its long-range focus.*
- *USD(A) should explicitly recognize the 6.1 program as an integrated corporate program and should re-assert the corporate budget and managerial authority already resident within OSD.*

DoD's top leadership needs to reaffirm its commitment to a long range, basic research program and it needs to reassert the role of OSD in management and oversight of this program. This recommendation is consistent with the thrust of the Packard Commission:

- Short lines of authority and simplification of the management process.
- Defined authority and responsibility.
- Adoption of successful industrial management principles where appropriate.
- Strong central policy and program definition--and then freedom to perform.

The Study group believes that these recommendations should be carried out now.

6.1 BASIC RESEARCH - RECOMMENDATIONS

- USD(A) REAFFIRM IMPORTANCE OF 6.1 AND ITS LONG-RANGE NATURE IN POLICY STATEMENT

- TO EXECUTE INTEGRATED CORPORATE 6.1 PROGRAM, USD(A) SHOULD ASSERT AUTHORITY TO:
  - DELEGATE ACQUISITION EXECUTIVE AUTHORITY TO SINGLE INDIVIDUAL
  - SET 6.1 SERVICE AND AGENCY FUNDING LEVELS
  - ASSURE THIS INDIVIDUAL HAS AUTHORITY FOR PROGRAM DIRECTION OF SERVICE/AGENCY 6.1 ACTIVITIES
  - BALANCE PROGRAM; REVIEW QUALITY AND EXECUTION

- QUALITY OF LEADERSHIP IMPORTANT TO PROGRAM SUCCESS

- CARRY OUT THIS ACTION NOW

LABORATORY MANAGEMENT

Every laboratory must have a specified mission. This requires a focus in the laboratory's R&D program as well as appropriate allocation of resources. If laboratory resources are too diffuse and/or if the laboratory is not performing technically at standards required to meet laboratory objectives, it should be rapidly strengthened and re-oriented, converted to a GOCO or closed.

Given the current situation of many DoD laboratories and the belief that their problems will likely worsen in the future, the focus of the panel was on formulating recommendations which could increase the effectiveness and continuity of DoD laboratories. The Group developed three recommendations for enhancing the effectiveness of DoD laboratories. These recommendations are presented in the viewgraphs to follow.

LABORATORY MANAGEMENT

FINDINGS

- LABS (GOCO OR GOVERNMENT) REQUIRE MISSION, FOCUS AND CRITICAL MASS
- STRENGTHEN, CONVERT, OR CLOSE IF NOT PERFORMING
- FOCUS ON MEASURES TO INCREASE EFFECTIVENESS AND CONTINUITY
  - TECHNICAL LEADERSHIP
  - PERSONNEL

WE PRESENT THREE RECOMMENDATIONS

DOD LABORATORIES CONTROL MOST OF 6.1 AND 6.2 TECHNOLOGY BASE

The importance of the DoD laboratories to DoD's total acquisition program is not always evident. Not only do they perform a high fraction of the 6.1 and 6.2 work but they also control or manage much of the rest of the Technology Base and are principal technical monitors for later stage acquisition programs. Thus, the quality of the laboratories and their technical leadership are of supreme importance to DoD.

New one

DOD LABORATORIES CONTROL MOST OF 6.1 AND 6.2 TECHNOLOGY BASE

- THEY PERFORM (FY 87)

32% OF 6.1	$300 MILLION
43% OF 6.2	$1 BILLION

- THEY CONTROL AND MANAGE MUCH OF THE REST

THEREFORE—QUALITY OF THE LABORATORIES AND THEIR LEADERSHIP ARE OF SUPREME IMPORTANCE

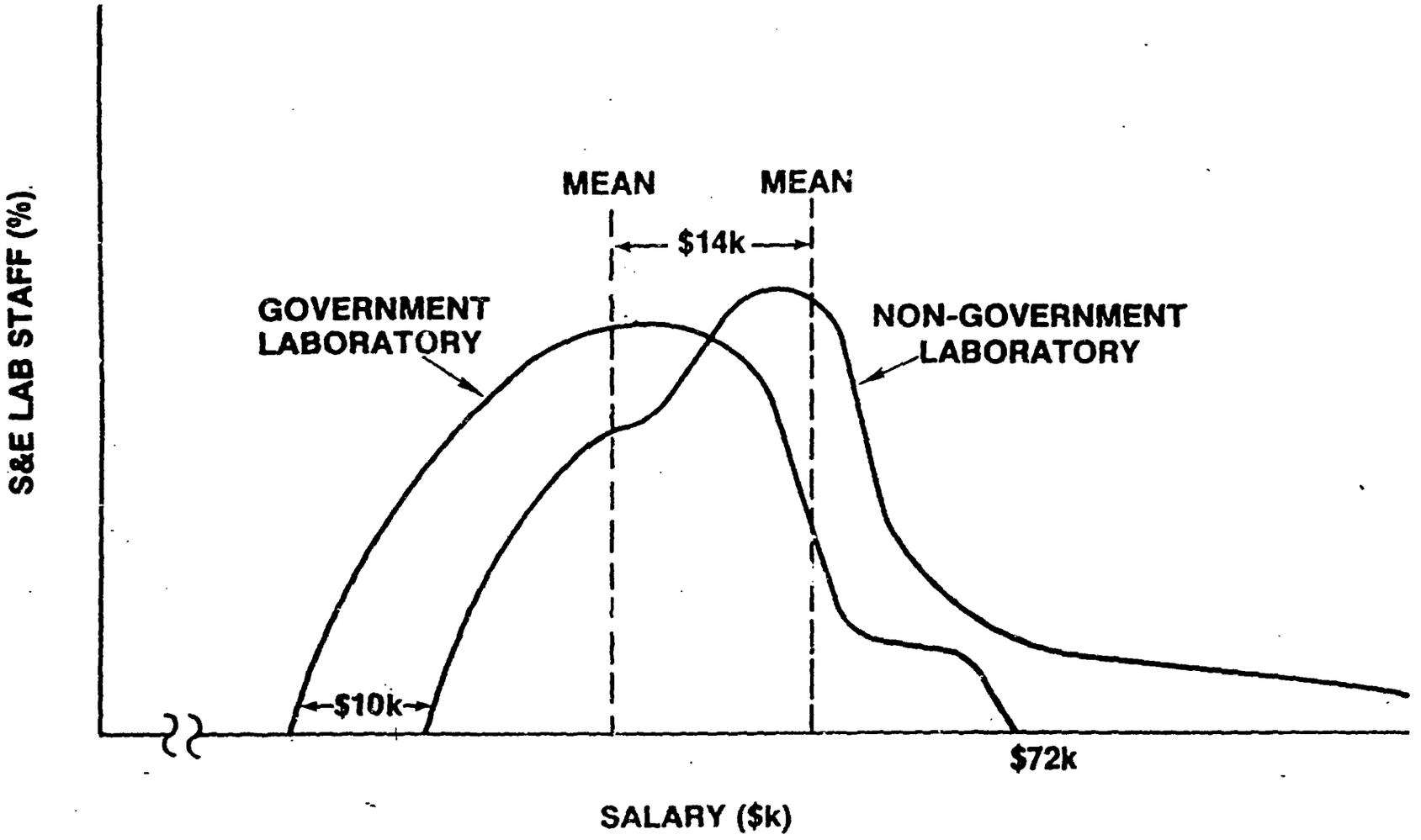
S&E SALARY COMPARISON

The following factors are important in attracting and retaining high quality technical personnel:

- High quality colleagues.
- Opportunity to work on exciting, significant projects.
- An environment conducive to high quality technical work, including management, equipment, technical support and procurement.
- Adequate salaries and opportunities for advancement, including continuing education.

Compensation allowed by the Civilian Service system is a major inhibitor to attracting and maintaining quality technical staff within in-house DoD laboratories. The inability to compete with industrial R&D centers for the best technical talent is graphically illustrated by this figure, which plots S&E salary for one government laboratory against that for a GOCO laboratory. The lower end of the curves indicates that starting salaries for representative newly graduated S&E's with bachelors degrees differ by roughly $10,000. This comparison indicates that they are probably not hiring the same quality of person. The difference in the mean salary is $14,000 again indicating a potential difference in personnel quality. At the high end government laboratory S&E salaries cut off at $72,000, by law. Premier technical achievers at the GOCO laboratory are paid twice or even more than that amount. This difference is crucial since it is generally agreed that research and development relies heavily on a small percentage of unusually talented individuals.

S&E Salary Comparison



TWO LABORATORY MANAGEMENT RECOMMENDATIONS FOR DOD-WIDE IMPLEMENTATION NOW BY USD(A)

The Study group formulated two kinds of recommendations for substantively improving the DoD laboratories. The first kind recommends making DoD-wide laboratory changes. There are two recommendations of this type, as listed on the facing viewgraph and below.

Recommendation: USD(A) should take immediate positive action to expand the NOSC/NWC (China Lake) personnel experiment to all DoD laboratories for all scientists and engineers (S&E's). In addition, necessary changes in law and regulations should be made to extend the probationary period for laboratory S&E hires from one year to three years.

USD(A) should direct that the individual Services establish a clear line of responsibility, authority and accountability to each laboratory/technical director and that these laboratory/technical directors be appointed for five years, renewable upon review.

The second kind of recommendation provides a proposal for conducting limited demonstration projects which experiment with other management mechanisms to test their efficacy before broad use.

Recommendation: USD(A) direct each Service to create at least one demonstration laboratory project which attracts and retains highest quality staff; improves contracting effectiveness; improves personnel management; and provides local laboratory management authority and accountability.

Each recommendation is discussed in the next several viewgraphs.

TWO LABORATORY MANAGEMENT RECOMMENDATIONS FOR DOD-WIDE IMPLEMENTATION NOW BY USD(A)

- EXPAND NOSC/NWC EXPERIMENT (CHINA LAKE) TO ALL DOD LABS FOR ALL S&E'S. EXTEND PROBATIONARY PERIOD FOR S&E HIRES TO THREE YEARS

- ASSURE THAT EACH SERVICE ASSIGNS RESPONSIBILITY, AUTHORITY, AND ACCOUNTABILITY TO LAB DIRECTORS, APPOINTED FOR FIVE YEAR TERMS, RENEWABLE UPON REVIEW

FIRST RECOMMENDATION: PERSONNEL MANAGEMENT (CHINA LAKE)

The dominant factor in the quality of the in-house laboratories is the quality of their personnel; in particular, their scientists and engineers. The Study group concluded that improvements to the personnel system are critically needed to assure that DoD laboratories can attract and retain top quality technical people.

The Civil Service Reform Act of 1978 authorized the use of experimental personnel systems to demonstrate improved personnel management in government. One such demonstration program has been conducted at two Navy laboratories, the Naval Ocean Systems Center, San Diego, California and the Naval Weapons Center, China Lake, California. This "Demonstration Program" was to test the introduction of representative private sector personnel practices into public sector laboratories.

The Demonstration Program contained six elements which are important to improvement of the quality of personnel in laboratories:

- A simplified classification system which allows optimal development and use of scientists and engineers and which minimizes the personnel system process.
- A simplified and improved performance evaluation system.
- A performance-based pay system, allowing laboratory management to award high performance.
- Provision for starting salaries for new professional scientists and engineers which are competitive with those of the private sector.
- Performance-based retention in time of Reduction in Force.
- Rewarding bench-type S&E's (non-management) for technical contribution rather than management.

The Study Group has reviewed this demonstration project and finds that it has been highly successful in the two laboratories. Similar findings have been established by other reviews including the Packard Commission. The group recommends that the Department of Defense immediately and strongly support action to extend this successful personnel management system to all scientists and engineers in the in-house laboratories.

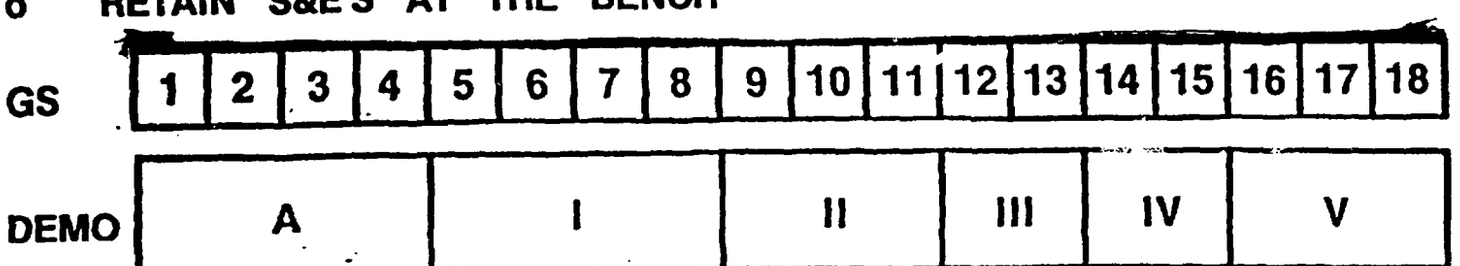
A further improvement in personnel management would be to change the probationary period for newly hired laboratory S&E personnel from the current one year to a more meaningful and useful three year period. Experience with laboratory new hires is that one year is an insufficient time period in which to evaluate properly the capability and potential value of a new S&E hire.

FIRST RECOMMENDATION: PERSONNEL MANAGEMENT (CHINA LAKE)

REC: DOD STRONGLY AND IMMEDIATELY SUPPORT LEGISLATION TO EXTEND THE NAVY PERSONNEL DEMONSTRATION PROJECT TO ALL IN-HOUSE DOD LABORATORY S&E'S

FACTORS:

- **SIMPLIFIED CLASSIFICATION**
- **IMPROVED PERFORMANCE ASSESSMENT**
- **PERFORMANCE-BASED PAY**
- **COMPETITIVE STARTING SALARIES**
- **PERFORMANCE-BASED RETENTION IN RIF**
- **RETAIN S&E'S AT THE BENCH**



SECOND RECOMMENDATION: LAB DIRECTOR AUTHORITY FOR TECHNOLOGY PROGRAM EFFICIENCY AND STABILITY

A successful technology base program requires stable goals and leadership so that multi-disciplinary research teams can be established and equipped to perform the necessary work. This process requires stability in the technical leadership of the programs as well as sufficient authority in the laboratory direction to maintain program continuity. For the Technology Base program to operate efficiently, each laboratory/technical director must be given the responsibility and authority to manage his program and be held accountable for the productivity of this program. This recommendation strives for stability and authority for DoD laboratory/technical directors. Some DoD in-house laboratory/ technical directors have been reassigned as frequently as once every 10 months which precludes such a central, sustained direction of the technical program.

SECOND RECOMMENDATION: LAB DIRECTOR AUTHORITY FOR TECHNOLOGY PROGRAM EFFICIENCY AND STABILITY

- ASSIGN CLEAR LINE OF
  - RESPONSIBILITY
  - AUTHORITY
  - ACCOUNTABILITY

  TO THE LABORATORY/TECHNICAL DIRECTOR FOR
  - PROGRAM CONTENT
  - PROGRAM EXECUTION
  - PERSONNEL POLICIES
  - ALLOCATION OF APPROVED BUDGETS
- STABILIZE ASSIGNMENTS OF LABORATORY/TECHNICAL DIRECTORS
  - 5 YEAR APPOINTMENTS
  - RENEWABLE UPON REVIEW
  - PROVISION TO REMOVE FOR CAUSE

THIRD RECOMMENDATION: LABORATORY DEMONSTRATION PROJECT

The Study group strongly believes that laboratory problems with personnel, contracting, and the authority (or lack thereof) of the laboratory directors, strongly inhibit high productivity. The Study group was discouraged by the prospects for improvement of productivity through conventional types of recommendations. Even the highly successful personnel demonstration projects conducted at the Naval Ocean Systems Center (NOSC) and at the Naval Weapons Center (NWC) China Lake did not go far enough.

This Study group now proposes several much more ambitious demonstrations to address remaining personnel problems and to address the problems of facilities and equipment, contracting, and the authorities of the laboratory directors. As envisioned by the Study group, the basic objectives of such DoD laboratory demonstration projects should be to provide:

- An ability to compete equitably in the market place for scientific staff.
- Reduced administrative requirements.
- Streamlined contracting.
- Authority to the directors of the laboratories to manage their laboratories.

The group recommends that each Service create at least one demonstration laboratory project to meet these objectives.

THIRD RECOMMENDATION: LABORATORY DEMONSTRATION PROJECT

- CREATE AT LEAST ONE DEMONSTRATION LAB PROJECT PER SERVICE WHICH
  - ATTRACTS AND RETAINS HIGHEST QUALITY STAFF
  - IMPROVES CONTRACTING EFFECTIVENESS
  - IMPROVES PERSONNEL MANAGEMENT
  - PROVIDES LOCAL LABORATORY MANAGEMENT AUTHORITY AND ACCOUNTABILITY

LABORATORY MANAGEMENT LAB DEMO PROJECT SPECIFICS

Although the detailed attributes of these demonstration laboratory projects should be tailored to the needs of the Services and the specific laboratory selected, the project should incorporate, as a minimum, the following:

- A basic personnel system similar to those demonstrated at NOSC and NWC, with perhaps broader pay bands.
- A provision for hiring senior scientific and technical staff at salaries higher than for Executive Level V. The number of such positions should not exceed ten percent of a laboratory's scientific and technical staff and should be considered to be in the Excepted Service (untenured) as defined in Title IV, Section 2103, of the United States Code. These positions are, however, to be filled through national competition. A mechanism for setting and adjusting pay should be provided through a market survey. In this regard consideration should be given to methods used to set pay for the Uniformed Services University of the Health Sciences (see Public law 92 - 426) and to those described in Senate Bill 1477 entitled "Federal Science, Technology, and Acquisition Revitalization Act."
- Direct hire authority and simplified removal procedures for laboratory/technical directors.
- Installation of a private sector methodology for procurement, with all necessary procurement authorities vested in the laboratory director.
- Removal of financial limits on a laboratory director's ability to utilize overhead funds for renewal and maintenance of the laboratory's research facilities and equipment.

The demonstration projects may be accomplished within the federal system or may be accomplished through the conversion of the demonstration laboratories from the federal service to government owned contractor operated (GOCO) laboratories. In the event that it is concluded that the desired objectives of the demonstration projects cannot be met within the federal service then they, in fact, should be carried out through conversion to GOCO. The spectrum of laboratories chosen for demonstration projects should encompass research laboratories as well as product or systems laboratories. The chosen laboratories should be representative in size for each service laboratory complex.

LABORATORY MANAGEMENT
LAB DEMO PROJECT SPECIFICS

- o NAVY DEMONSTRATION BASIC PERSONNEL SYSTEM FOR ALL TENURED EMPLOYEES
- o PROVISION FOR SPECIAL UNTENURED S&E'S
  - SPECIAL SALARY RATES DETERMINED BY COMPENSATION SURVEY
    - > EXEC LEVEL IV -- NO CAP
    - NOT TO EXCEED 10% OF S&E'S IN DEMONSTRATION LABORATORY
- o DIRECT HIRE AUTHORITY AND SIMPLIFIED REMOVAL PROCEDURES
- o IMPROVED PROCUREMENT PRACTICES
  - USE PRIVATE SECTOR METHODOLOGY
  - AUTHORITY VESTED IN LABORATORY/TECHNICAL DIRECTOR
- o EMPLOY FINANCIAL SYSTEMS THAT PROVIDE LOCAL AUTHORITY FOR USE OF LABORATORY FUNDS (e.g. OVERHEAD) FOR NEW FACILITIES AND EQUIPMENT

IF DEMONSTRATION CAN'T BE DONE, CONVERT TO GOCO

SENIOR SCIENTIFIC, TECHNICAL, AND ACQUISITION EXECUTIVE INITIATIVE

The objective of the second "demonstration" recommendation, the Senior Scientific, Technical and Acquisition Executive Initiative, is to upgrade significantly the technology management skills available within DoD for management of its technology base programs.

Recommendation: USD(A) establish a 6-year experiment to determine the effectiveness of a Senior Scientific, Technical and Acquisition Executive initiative. This initiative should establish up to 100 non-tenured appointments in DoD with the goal of significantly strengthening critical technology skills, Technology Base management, and Defense Acquisition management.

Candidates for such appointments could come from industry, from private laboratories or from universities, with appointees serving 3-year terms, renewable after review. Compensation should be competitive with similar positions in industry and the universities. Compensation could be established and administered in a manner similar to that established in P.L. 92-426 or proposed in Senate Bill S-1477. This demonstration project should be administered out of the USD(A) office.

Senior personnel hired through this demonstration could be used to:

- Provide special S&E expertise to assist in the management and oversight of the Technology Base Program.
- Provide an adjunct and linkage between the Office of the Vice Chairman of the JCS and the DoD Technology Base Program.
- Provide liaison and linkage with the CINCs and the worldwide family of Service users.
- Provide an increased interface between international technology activities and the DoD Technology Base Program.
- Provide specialized on-call technical expertise to support individual DoD Laboratories or technology programs as might be mutually agreed to by USDA and the requesting Service activity.
- Provide proven and effective acquisition skills in OSD and the Service staffs.

The conflict of interest issue is seen as the most serious impediment to the implementation of this experiment. Although management of job assignments can resolve a sub-set of this issue, some form of conflict of interest waiver (requiring legislative action) will be required to make the experiment truly effective.

SENIOR SCIENTIFIC, TECHNICAL, AND ACQUISITION EXECUTIVE INITIATIVE

PURPOSE: STRENGTHEN CRITICAL TECHNOLOGY SKILLS AND TECHNICAL/ ACQUISITION MANAGEMENT IN DOD

RECOMMENDATION: DEMONSTRATION PROGRAM

- 100 NON TENURED APPOINTMENTS
- PARTICIPANTS FROM INDUSTRY, UNIVERSITIES, NON-GOVERNMENT LABS
- COMPENSATION MARKET DRIVEN
- 3 YEAR TERM - 6 YEAR EXPERIMENT
- ADMINISTER OUT OF USD(A)
- EXPERIMENT MUST ADDRESS CONFLICT OF INTEREST ISSUE

6.3A AND TECHNOLOGY TRANSITION

Present and past national research and exploratory development programs have demonstrated an abundance of innovation resident within the U.S. scientific and engineering communities and have resulted in significant contributions to our defense systems capabilities. Both incremental improvements and major leaps forward in warfighting capability have grown out of U.S. basic research and exploratory development programs. Many examples of steady improvements exist in the areas of materials, propulsion system, radar and electro-optic sensor, medical and space technologies, for example. However, examples of major opportunities for quantum advances in system performance in the areas of directed energy weaponry, remote stand-off weaponry, stealth technology, microelectronics and submarine laser communication, among many others, exist and remain largely untapped. This DSB Study as well as all previous Technology Base studies have concluded that the problem of rapid technology transition to fielded systems is a key issue standing in the way of truly successful defense R&D management.

The DSB believes that both the Defense Department and commercial industry are seriously deficient in rapid technology transition into systems and products. This situation is a primary contributor to a growing crisis in military competition as Soviet weapons system performance approaches and, in some cases, exceeds that of U.S. and Allied forces. Since we can anticipate general numerical inferiority to Eastern Bloc and other potentially hostile forces, outcomes of conflict with these forces could be disastrous for the U.S. in the future unless this situation is reversed or otherwise offset by technology.

6.3A TECHNOLOGY TRANSITION

WHAT IS THE PROBLEM

- RAPID AND EFFECTIVE TRANSITION OF ADVANCED TECHNOLOGY TO FIELDED SYSTEMS AND FORCES IS CRITICAL
- PEACETIME PERFORMANCE DEFICIENT
  - ACQUISITION CYCLE TOO LONG
  - SHORT CUTS WHICH AVOID TECHNOLOGY DEMONSTRATIONS FREQUENTLY FAIL

6.3A TECHNOLOGY TRANSITION

The Defense Science Board believes the greatest opportunity to improve the rate and effectiveness of this transition process is by increasing our focus on the early advanced development phase of the S&T program, that is, Budget Category 6.3A.

Recommendation: USD(A) employ 6.3A for Advanced Technology Transition Demonstration projects (ATTD) to sharpen DoD's focus on technology transition.

- *Building and testing experimental systems in field environment to establish technical feasibility and field utility before a system commitment and FSED decision are made.*
- *Use specific management principles to guide these projects.*
- *Direct (by FY91) half or more of 6.3A to ATTD projects - approximately $1B or 2-1/2% of RDT&E (do not use 6.1 or 6.2 funds)*
- *For all ATTD projects request Vice Chairman JCS to review annually to assure projects address future military user needs*

Incremental improvements to existing systems are the easiest to accomplish since they are generally cheaper and require the least amount of risk. Radical new technology embodied in new systems often yields the greatest performance advantages over our adversaries but achieving acceptance of these results is far more difficult. The underlying reason for this is that new concepts require greater risk, incur higher costs, and often affect existing doctrine or tactics. In order to overcome these barriers, the DSB believes that two areas of Defense management emphasis are needed for oversight of 6.3A programs:

- Careful selection and timely execution of system(s) and major sub- system(s) Advanced Technology Transition Demonstrations (ATTD) to build and test experimental systems in a field environment. Such ATTDs must be focussed on establishing both:
  - technical feasiblity, and
  - field utility.

  Further, ATTDs must be conducted before the system commitment and FSED decisions are made.
- Careful attention should be paid to the selection to criteria and management principles which have proven effective during past technology development and demonstration efforts.

6.3A TECHNOLOGY TRANSITION

SOLUTION EMPLOY 6.3A

ADVANCED TECHNOLOGY TRANSITION DEMONSTRATION PROJECTS (ATTD)

BUILD AND TEST EXPERIMENTAL SYSTEMS IN FIELD ENVIRONMENT–TO ESTABLISH EXPEDITIOUSLY

- TECHNICAL FEASIBILITY
- FIELD UTILITY
- BEFORE SYSTEM COMMITMENT AND FSED DECISION

6.3A TECHNOLOGY TRANSITION

The concept of Advanced Technology Transition Demonstrations (ATTD) as viewed by the DSB is consistent with the views on technology transition and prototyping expressed by the Packard Commission. Conceptually, the ATTD activity can be viewed as an extension of the Packard Commission prototype recommendation to include technology demonstrations without being committed to a defined systems development program. The criteria for establishing ATTD projects should include the following:

- Provide a risk reducing "Proof of Principle" demonstration to be conducted at the system or major subsystem level in an "operational" environment rather than the "laboratory" environment.
- Exhibit potential for new or enhanced military operational capability or significant improvement in cost effectiveness.
- Have a duration of one to four years (typically).
- Have a total program cost of $10M to $100M (typically).
- Have a transition plan in place at the outset of the ATTD. Potential system applications and transition windows should be identified at this time.
- Participation by the user (operator). The user should normally serve as the program sponsor.
- Participation by the developer (systems command). The developer should serve as project manager for the demonstration.
- ATTD resources provided by a separate 6.3A resource sponsor, with follow-on program resources programmed at ATTD program outset by program sponsor.

To ensure that ATTD projects address joint/unified command needs as well as technological opportunities, the DSB feels that the Vice Chairman of the JCS should develop a mechanism whereby he can be kept aware of Service intentions and opportunities for such projects. He should be made aware of projects in the planning phase so that he can provide guidance and direction prior to program execution. Use of the JROC to conduct an annual review of planned service and agency ATTD projects is an option he might consider for this purpose.

6.3A TECHNOLOGY TRANSITION

- PROJECT SELECTION OF AN ATTD ~ $100M SIZE MAXIMUM
  - FOR JOINT OR DARPA PROJECT

    USD(A) SELECTS; MAY WISH TO EMPLOY PROTOTYPE ADVISORY COUNCIL HELP
  - FOR SERVICE PROJECT

    USD(A) DELEGATES TO SERVICE ACQUISITION EXECUTIVE
- FOR ALL ATTD PROJECTS REQUEST VICE CHAIRMAN JCS TO REVIEW ANNUALLY TO ASSURE PROJECTS ADDRESS FUTURE MILITARY USER NEEDS

KEY ATTRIBUTES FOR SUCCESS FOR ATTD PROJECTS

Prototyping and other advanced technology demonstration projects have proven their value in past years for injecting new technology into operational military hardware. Nevertheless, because the Advanced Technology Transition Demonstrations (ATTDs) recommended here are to be specifically aimed at accelerating technology transition, close attention must be paid to the key attributes that distinguish these from other 6.3A projects (see the listing on the facing viewgraph). The DSB believes that a clear statement of these selection criteria and management principles will help focus management attention on the essential characteristics that must be embodied in an ATTD if it is to achieve the objectives the Study Group intends. It is the view of the DSB that most ATTDs should be selected and managed in a less rigid and more streamlined manner than current DoD prototyping projects. ATTDs which are joint or multi-service in nature should receive JCS attention; however, others should be managed at the individual service/agency level.

The formulation process for each Advanced Technology Transition Demonstration project should embody the following principles:

- Stimulate clear definition of the operational military capability to be demonstrated.
- Evoke strong acceptance and sponsorship for the demonstrated capability among operational military commanders.
- Include representatives of the research, development, production, and operational viewpoints in selection of the technologies and concepts to be demonstrated.
- Ensure that selection of ATTD projects is based upon competition for the best ideas to be pursued within overall ATTD funding constraints.
- Assure that the demonstration, if successful, clearly proves both the maturity of the technology and the satisfaction of a perceived military need.
- Provide appropriate visibility for such demonstration projects to OSD, senior military operational commanders, and to the Congress.
- Provide adequate financial resources to meet all the goals specified for the project and obtain a commitment by the appropriate Service/s to initiate follow-on development if the demonstration is successful.

KEY ATTRIBUTES FOR SUCCESS FOR ATTD PROJECTS

- CLEAR CONCEPT OF EMPLOYMENT
- TECHNOLOGY MATURITY
- COMPLEMENTARY TECHNOLOGY READINESS
- TIMELINESS WITH RESPECT TO "WINDOWS OF OPPORTUNITY"
- RECEPTIVE INSTITUTIONAL CLIMATE
- USER INVOLVEMENT
- SERVICE DEVELOPER INVESTMENT
- COMPETENT INDUSTRY PRACTITIONERS
- KNOWLEDGEABLE DEVELOPMENT PROJECT TEAM

EXAMPLE ATTD

There have been a number of past successes in programs which met the criteria for a successful ATTD. The following examples are considered representative of successful ATTD-type programs:

Past (Successes)

- MINET - Netted Training Simulator
- Shape Stable Reentry Vehicle
- SURTASS - Long Towed Array
- Teal Dawn - Advanced Cruise Missile

Now on Menu

- Supermaneuver Fighter Aircraft
- Submarine Laser Communications
- SAC Survivable Adaptive Planning Experiment
- Teleoperated Anti-Armor Vehicle

EXAMPLE ATTD

PAST (SUCCESSES)

- SIMNET - NETTED TRAINING SIMULATOR
- SHAPE STABLE REENTRY VEHICLE
- SURTASS - LONG TOWED ARRAY
- TEAL DAWN - ADVANCED CRUISE MISSILE

NOW ON MENU

- SUPERMANEUVER FIGHTER AIRCRAFT
- SUBMARINE LASER COMMUNICATIONS
- SAC SURVIVABLE ADAPTIVE PLANNING EXPERIMENT
- TELEOPERATED ANTI-ARMOR VEHICLE

6.3A TECHNOLOGY TRANSITION

Since the DoD's historical difficulty in transitioning new technology into its operational forces in peacetime is so severe, and since the promise of Advanced Technology Transition Demonstrations in facilitating this transition is so clear, the Defense Science Board has concluded that each Service should restructure its budget in this area to place greater emphasis on ATTD projects. Specifically, by 1991 the Study group believes that each Service should devote at least one-half of its 6.3A funding to ATTD projects.

As a department, therefore, DoD would be spending roughly one-half of its 6.3A funds or about $1 billion each year in facilitating technology transition into military capabilities. Considering the $10M-$100M range of such projects, this would equate to a minimum of approximately 20-30 such projects. The Board believes this is a reasonable number of projects at both the service/agency and the department level.

6.3A TECHNOLOGY TRANSITION

USD(A)--HOW YOU SHOULD DO IT

- **BUILD ON PROTOTYPING CONCEPT**
- **DIRECT (BY FY91) HALF OR MORE 6.3A TO ATTD PROJECTS**
  APPROXIMATELY $1B OR 2-1/2% OF RDT&E
  (DO NOT USE 6.1 OR 6.2 FUNDS)
- **INCLUDE**
  - **SERVICE PROJECTS**
  - **DARPA PROJECTS**
  - **JOINT PROJECTS**

6.3A TECHNOLOGY TRANSITION

The execution of an effective ATTD program is a particularly tough problem in today's environment. DoD must ensure that all ATTD procurements are based on a "competition of ideas" with an overall project cost target specified. "Best and Final Offer" (BAFO) - type procedures inhibit such competitions. In addition, DoD activities should place a premium on team building which involves 1) performers of research, 2) developers, 3) industry (the producers), and 4) military operators.

6.3A TECHNOLOGY TRANSITION

- PROJECT EXECUTION
  - DIRECT PROCUREMENT TO COMPETITION BASED ON IDEAS WITH OVERALL PROJECT COST TARGET SPECIFIED – BAFO PROHIBITED
  - PLACE PREMIUM ON TEAM WHICH INVOLVES PERFORMERS OF RESEARCH, DEVELOPERS, INDUSTRY AND OPERATORS
- TOUGH PROBLEM - WILL REQUIRE CONTINUOUS ATTENTION OF USD(A)

OTHER CENTRAL ISSUES ADDRESSED

There were a number of other central issues treated by the Summer Study Panel as listed on this viewgraph. A discussion of each will be included in the final report.

OTHER CENTRAL ISSUES ADDRESSED

- DUAL USE TECHNOLOGY
- INTERNATIONAL TECHNOLOGY BASE COOPERATION
- IR&D
- CONTRACTING
- BIOMEDICAL R&D
- RESEARCH FACILITIES AND EQUIPMENT

OTHER CENTRAL ISSUES

Three of these issues are discussed in the main briefing, as shown on this viewgraph.

Research Facilities and Equipment. Research and development depends upon the use of state-of-the-art equipment and facilities. Providing such facilities and equipment is made difficult by rapidly changing technology which outmodes equipment rapidly and by the increasing costs of renewing equipment and facilities. There is a concern that managers at the performance level do not have local authority to make rational tradeoffs within their budgets with respect to people, facilities, and equipment. For example, it may make more sense in the long run to purchase a significant piece of equipment, e.g., a molecular beam epitaxial (MBE) machine, than to continue to fund a group of researchers to milk the remaining use from an existing instrument. Local management should be permitted to make and implement such decisions.

Contracting for Technology Base R&D. The application of the regulations developed to implement the Competition in Contracting Act (CICA) to Technology Base activities has created a number of significant and far-reaching problems. Procuring agencies, from defense agencies to laboratories, are unable to procure needed services in a timely and useful fashion. Scientists and engineers in the defense community at large are unable to input new and innovative concepts into the defense R&D mainstream. There are at least two needed changes to Technology Base contracting. First, final authority for the procurement of 6.1 and 6.2 services must be returned to the responsible official, namely the Technology Base manager, i.e., the laboratory or agency director. Second, the competitive contracting mechanism known as the Broad Agency Announcement (BAA) should be applied in a broader context. Results for those agencies which have adopted this procedure have been very positive. The BAA should now be extended to 6.3A procurements to insure a competition of ideas.

IR&D. IR&D is another important part of the national Technology Base program. When properly utilized, IR&D results and products complement the DoD funded efforts. In addition, IR&D is an important mechanism for transferring technology and intellectual property between the commercial and military sectors. The Study group believes that the problems with IR&D are reaching crisis proportions. Recent acquisition system changes which have increased the pressure for industry cost sharing, reduced data rights and lower profits have also reduced industry's incentive to spend "over ceiling" for IR&D. Further, the pressure for increased competition and the joint cap on IR&D/B&P funds requires industry to shift expenditures from IR&D to B&P. There are also signs of increasing bureaucratic review of the IR&D program at a level of detail which impairs the fundamental purpose of IR&D. Increasing pressure for justification of short-term military relevance is causing shifts from R toward D in many industry IR&D programs.

OTHER CENTRAL ISSUES

A. STATE OF THE ART FACILITIES AND EQUIPMENT

- PROBLEM FOR INDUSTRY, LABS, UNIVERSITY
- NEED FLEXIBILITY TO MAKE TRADE-OFF AMONG PEOPLE, EQUIPMENT, AND FACILITIES

B. CONTRACTING - NEED APPROPRIATE MECHANISM FOR TECHNOLOGY BASE ACTIVITY

- USE BROAD AGENCY ANNOUNCEMENT FOR 6.2 AND 6.3A
- TECHNOLOGY MANAGER SHOULD DETERMINE PROCUREMENT MECHANISM FOR 6.1 AND 6.2

C. IR&D

o THE "R" PART OF IR&D IS CRITICAL PART OF TECHNOLOGY BASE

o IR&D IS IN CRISIS

BOTTOM LINE

This viewgraph summarizes the key points:

- For the DoD basic research program, the Undersecretary for Acquisition should delegate his acquisition executive leadership to an individual within his staff. This individual should be vested with full authority and responsibility for the 6.1 program.
- For improving the DoD laboratories, three recommendations are made, as listed. The first two recommendations outline DoD-wide changes. The third recommendation suggests several demonstration projects.
- To improve the quality of personnel involved in the management of the DoD Technology Base, the panel recommended another demonstration project. This demonstration project would bring in 100 senior managers to augment OSD, JCS, Service, and Agency organizations.
- Technology transition was found to be the issue of greatest concern to the Study group. The group recommends that budget category 6.3A be revitalized and focussed on the transition of technology through "Advanced Technology Transition Demonstrations" - ATTDs.
- Finally, a series of other issues were analyzed by the Study group and recommendations formulated on each.

We believe you will find our final report informative and useful.

BOTTOM LINE

1. 6.1 DELEGATE OSD ACQUISITION EXECUTIVE LEADERSHIP
2. LABS
   - o EXPAND CHINA LAKE EXPERIMENT
   - o AUTHORITY FOR LAB DIRECTOR
   - o DEMONSTRATION LAB PROJECT
3. SENIOR SCIENTIFIC, TECHNICAL AND ACQUISITION EXECUTIVE INITIATIVE
4. TECHNOLOGY TRANSITION--ESTABLISH ATTD
5. OTHER CENTRAL ISSUES

   IR&D, CONTRACTING, FACILITIES & EQUIPMENT ETC.